A Risk-Adjusted Performance Evaluation Of US And EU Hedge Funds And Associated Equity Markets Over The 2007-2009 Financial Crisis

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ABSTRACT

Hedge funds are considered to be market-neutral due to their unrestricted investment flexibility and more efficient market timing abilities (Ennis & Sebastian, 2003). They may also be considered as suitably unconventional assets for improving portfolio diversification (Lamm, 1999). The evidence from this study confirms the dominance of hedge funds over the CAC 40, DAX, S&P 500 and Dow Jones from 2004 to 2011. Overall, the Sharpe, Sortino, Omega, Jensen's alpha, Treynor and Calmar ratios illustrate that US hedge funds outperformed both EU hedge funds and the associated equity markets over this period. Evidence was also found that both US and EU hedge funds were more correlated with the S&P 500 and Dow Jones after the financial crisis of 2007-2009 than before the crisis.

Keywords: Hedge Funds; Omega.

1. INTRODUCTION

Hedge funds are defined as pooled investment vehicles that embody a variation of different investment strategies, which can include short and long positions, leveraged positions, and derivate positions to limit market exposure and to increase risk-adjusted returns (Amin & Kat, 2003; National Treasury, 2012). With no investment constraints, a hedge fund manager is capable of investing in any global market to maximise a fund's financial gains (Kanellakos, 2005). This implies that the different investment strategies available can satisfy a variation of investors with different risk preferences (Shin, 2012). As such, hedge funds are considered unconventional assets that contribute to a higher reward level, which can serve as a substitute for cash and bonds during a declining equity market (Lamm, 1999).

However, the certainty of performance persistence has been diluted by the many conflicting results found by past studies. On the one hand the proponents of hedge funds argue that their low correlation with the returns on traditional alternative assets, like currencies, bonds, mutual funds and other equities, therefore, make them a better risk-return trade-off vehicle (Fung & Hsieh, 1997; Lavino, 2000; Amin & Kat, 2003; Al-Sharkas, 2005). This low correlation with the rest of the asset universe is further enhanced because of their exemption from the Company Act of 1940 and from the Security Exchange Act of 1934, providing them greater flexibility regarding different investment options.

It is also argued that hedge funds generate positive alphas, which implies that hedge fund managers as a group have an investment ability and may possess private information that is unavailable to other investors (Li, 2006), thus emphasising the potential dominance of hedge funds. Also, with the possibility of implementing features, like lock up periods, redemption frequencies and notices, share restrictions and minimum investment

amounts, hedge funds can produce higher alphas as they earn an illiquidity premium (see Agarwal, Daniel & Naik, 2009; Li, 2006; Aragon, 2007). These arguments, therefore, suggest that with a higher level of illiquidity and investment flexibility hedge funds should be able to ensure performance persistence and dominance over other types of investment options. This is also emphasised by Ackermann, McEnally and Ravenscraft (1999) and Liang (1999) who found that hedge funds have the consistency of providing superior returns with higher volatility, due to their more active management approach, compared to the more passive managed mutual funds.

Studies conducted by McCarthy and Spurgin (1998) and Schneeweis and Spurgin (1998) also concluded that hedge funds can offer greater risk-adjusted returns than alternative investment options, thus incorporating a lower level of systematic risk (Brown, Goetzmann & Ibbotson, 1999; Liang, 1999). This is mainly possible because of their investment flexibility, their ability to hedge themselves in bear markets (Nicholas, 2004), as well as their superior market timing (Ennis & Sebastian, 2003).

There are also a number of other studies that argue for the superiority of hedge funds over other investment vehicles. Studies done by Ackermann, McEnally and Ravenscraft (1999), Edwards and Caglayan (2001a), Fung and Hsieh (2004) and Kosowski, Naik and Teo (2007) for example all found performance persistence in hedge funds. There are also those studies that found performance persistence to vary based on the market environment and differences in investment strategies (see for example Fung & Hsieh, 1997). Corroborating these findings, the study by Capocci, Corhay and Hübner (2005) reports evidence of yearly-based persistence in mid-performed particular hedge fund portfolios during bullish periods, while Duong (2008) found stronger performance persistence when monthly, quarterly or semi-annual returns are used instead of annual return data. Further evidence even suggested that performance persistence might decrease over a longer period (Agawal & Naik, 2000).

On the opposite side of the argument, evidence also abounds that performance persistence does not manifest at all among hedge funds. Brown, Goetzmann and Ibbotson (1999) and Schneeweis, Kazemi and Martin (2001), for example found no evidence of performance persistence for hedge funds. Edwards and Caglayan (2001b) also found that hedge funds are highly correlated with an equity market during a bear market, implying a downturn in returns during a downswing in the equity market. The main reason for the uncertainty regarding performance persistence of hedge funds, however, mainly stems from the high attrition rate among hedge funds (see Brown, Goetzmann, Ibbotson & Ross, 1992; Fung & Hsieh, 1997; Ackermann, McEnally & Ravenscraft 1999; Liang, 2000; Li, 2006). This implies that there is a relative high tendency for a significant number of hedge funds to close over a certain time period. Some of the reasons for the high attrition rate can be attributed to voluntary dropouts or due to poor performance, but not because hedge funds are associated as defunct funds (Li, 2006). Though, Amin and Kat (2003) argue that the aggressive attitude of hedge fund managers may be a significant factor that contributes to a high attrition rate.

Given the contrasting results above, it is difficult to assess whether hedge funds are indeed superior investment vehicles. Overall, hedge funds employ highly skilled managers (Shin, 2012), and are excluded from the regulations governing public issuance of securities (Duong, 2008), which allows them to employ a myriad of techniques that allow them to outperform 'normal' investment vehicles.

This study will, evaluate both United States (US) and European (EU) hedge funds over three different periods to establish performance dominance during different market trends. The performance of these hedge funds will be evaluated by employing the Sharpe ratio, Sortino ratio, Treynor ratio, Jensen's alpha, Calmar ratio, Omega ratio and an Exponential-Weighted Moving Average (EWMA) model. These hedge fund's performances will be measured over the pre-financial crisis, financial crisis and post-financial crisis periods, respectively, in order to establish if the 2007 – 2009 financial crisis, which originated in the US, and the current (2012) debt crisis in the EU have influenced performance dominance. Furthermore, by evaluating these hedge funds against the DAX, CAC 40, S&P 500 and the Dow Jones, it is possible to establish whether hedge funds outperformed associated equity markets and if a normal buy-and-hold-strategy on these equity markets were the better option than to invest in a US or EU hedge fund. In order to achieve these objectives this paper will commence by discussing the most dominant risk-adjusted performance measures as emphasised by past studies (Section 2). The empirical results will then be reported in Section 3, followed by the concluding remarks and recommendations in Section 4.

2. RISK-ADJUSTED PERFORMANCE MEASURES

The Sharpe ratio remains one of the most commonly used statistics in financial analysis. It is, therefore, not surprising that market participants – whether investors or fund managers – still employ the Sharpe ratio as the performance measure of choice (see for example Lo, 2002; Bailey & López de Prado, 2012, p. 3; Schuster & Auer, 2012; Auer & Schuhmacher, 2013). Before Sharpe formulated his famous ratio, Jack Treynor developed the Treynor ratio in 1965. This ratio is identical to the ratio Sharpe developed in 1966, but differs with respect of the risk measure used. The Treynor ratio can be expressed as (adapted from Treynor, 1965):

$$\text{Treynor ratio} = \frac{R_p - r_f}{\beta_p} \quad (1)$$

where r_p denotes the return of a portfolio or security; r_f denotes the risk-free rate; and β_p is utilised as risk metric, thus incorporating market risk. Sharpe's ratio veers away from market risk, only considering the volatility of the portfolio around its own mean as a risk measure. The Sharpe ratio can thus be expressed as (adapted from Sharpe, 1966):

$$\text{Sharpe ratio} = \frac{R_p - r_f}{\sigma_p} \quad (2)$$

where σ_p is the standard deviation of portfolio returns. Sharpe's ratio thus allows for the measurement of the risk premium of the portfolio, for every unit of risk assumed. Therefore, it is obvious that, like with Treynor's ratio, the portfolio with the greater Sharpe value will be the best performing portfolio on a risk-adjusted basis. However, although these two measures are so alike, they do not always render similar results. It is thus possible for a portfolio with a relatively large unique risk to outperform the market when looking at the Treynor's ratio, but underperform the market when using Sharpe's ratio (Deb, 2012).

Despite the Sharpe ratio's popularity, there are still some pitfalls to consider when applying it as performance measure in cases where its underlying assumptions are breached (Auer & Schuhmacher, 2013, p. 154; Schuster & Auer, 2012, p. 124). As such the Sharpe ratio generally fares better in ranking the performance of less volatile returns (such as that of mutual funds), but poorer when highly volatile returns are gauged (Lo, 2002, p. 36). Since hedge funds make use of derivative instruments, their returns often follow an asymmetrical distribution with fat tails (thus a non-normal distribution), thus reducing the Sharpe ratio's ability to handle these returns (Fung & Hsieh, 1999a; Eling, 2008). In such circumstances, the Sharpe ratio tends to overestimate true risk (Brooks & Kat, 2002). This leaves market participants, with a skewed perception of the real risk inherent in hedge funds.

It is, therefore, necessary to look wider than the standard Sharpe ratio when comparing hedge fund performance with anything. To this end, several studies have included a variety of measures to gauge the performance of hedge funds. Gregoriou and Rouah (2002), for example employed both the Sharpe ratio and the Treynor ratio while Brown, Goetzmann and Ibbotson (1999) used the Sharpe ratio and Jensen's alpha. In their paper on the influence of different performance measures on the evaluation of hedge funds, Eling and Schuhmacher (2007) employed thirteen different performance measures, and reported that the rankings according to the Sharpe ratio and the other performance measures were very similar.[1] Eling (2008) also went on to test the performance rankings of a wider population of asset classes including stocks, bonds, real estate, hedge funds, funds of hedge funds, Commodity Pool Operators (CPOs) and Commodity Trading Advisors (CTAs) by employing eleven performance measures including the Sharpe ratio.[2] Moreover, there have also been studies, like Sedzro (2009), who have consulted not only the Sharpe ratio and Modified Sharpe ratio, but have used additional statistical models, like the Data Envelopment Analysis (DEA) method and the Stochastic Dominance (SD) method, to generate performance rankings.

[1] Eling and Schuhmacher (2007) employed the standard Sharpe ratio, the modified Sharpe ratio, the Treynor ratio, Jensen's alpha, the Sortino ratio, Kappa 3, the upside potential ratio, the Calmar ratio, the Sterling ratio, the Burke ratio, the excess return on value at risk, the conditional Sharpe ratio and Omega.

[2] Eling (2008) employed the modified Sharpe ratio, the Sortino ratio, Kappa 3, the upside potential ratio, the Calmar ratio, the Sterling ratio, the Burke ratio, the excess return on value at risk, the conditional Sharpe ratio and Omega against the Sharpe ratio as a benchmark.

In order to measure the impact of the 2007-2009 financial crisis on hedge funds a combination of ratios used by Eling and Schuhmacher (2007), Brown, Goetzmann and Ibbotson (1999), as well as Gregoriou and Rouah (2002) were chosen. These ratios were selected to rank the sample of hedge fund and market index returns in order to escape some of the shortcomings of using only Sharpe in modelling volatile returns. Also, to extent the risk perception and the shortcomings of the Sharpe and Treynor ratio additional ratios were also employed.

2.1 Measures other than Sharpe and Treynor

Where Treynor and Sharpe's indexes provide measures for ranking the relative performances of various portfolios on a risk-adjusted basis, Jensen (1968) attempted to construct a measure of absolute performance on a risk-adjusted basis, i.e., a definite standard against which performances of various portfolios can be measured. This standard is based on measuring the 'portfolio manager's predictive ability' (the ability to earn returns through successful prediction of security prices), which are higher than those expected, given the level of riskiness of his portfolio, the expectation being based on the Capital Asset Pricing Model (CAPM).

This is an attempt to determine if returns, more than that expected based on CAPM, are being earned for the portfolio's riskiness. A simplified version of his basic model is given by (adapted from Jensen, 1968):

$$R_p - r_f = \alpha_p + \beta_p \cdot \left(R_m - r_f\right) \tag{3}$$

where R_p is the average portfolio return for the period concerned; r_f is the risk-free rate for the same period; R_m is the average market return or the return of the index for the portfolio concerned for the same period; and α_p is the Jensen's Alpha.

The α_p based on CAPM, on average, should be zero in the long-run, indicating neutral performance by a portfolio, i.e., the portfolio has done just as well as an unmanaged market portfolio or a large, randomly selected portfolio manager with a naive buy-and-hold strategy. A positive value of α_p represents a superior performance on the part of the portfolio manager. On the other hand, a negative value of α_p indicates inferior management performance, because management did not do as well as an unmanaged portfolio of equal systematic risk.

The Sortino ratio differs from Sharpe in another way: it applies downside deviation as denominator instead of overall standard deviation. It, therefore, only considers "bad" volatility (Sortino & Van der Meer, 1991, p. 29), thus solving for the asymmetric characteristics of the return distribution of hedge funds, as is clear in Equation 4 below (adapted from Eling & Schuhmacher, 2007):

$$\text{Sortino ratio} = \frac{r_i^d - r_f}{\sqrt[n]{LPM_{ni}(\tau)}} \tag{4}$$

where r_f is the risk free rate and the Lower Partial Moment (LPM) can be written as:

$$LPM_{ni}(\tau) = \frac{1}{T}\sum_{t=1}^{T} \max[\tau - r_{it}, 0]^n \tag{5}$$

The Sortino ratio's ability to capture downside risk lays in the fact that it uses a LPM of the second order (thus $n = 2$) to capture the semi-variance of returns. Since LPMs only consider negative deviations from a minimal acceptable return (normally a risk free rate), it trumps standard deviation that captures both positive and negative deviations of expected returns. The other ratio used that employs LPMs is Omega.

Omega does not only capture LPMs, but also Higher Partial Moments (HPMs), thus taking the positive deviations of expected returns above a minimal acceptable returns into consideration. In doing this, Omega provides a risk-reward evaluation that incorporates both the beneficial impact of gains and the unfavourable effect of losses, relative to any investor's threshold (Shadwick & Keating, 2002). The ability of Omega to capture both sides of the 'Partial Moment coin' is visible from Equation 6 below (Eling & Schuhmacher, 2007):

$$\text{Omega} = \frac{r_i^d - \tau}{LPM_{ni}(\tau)} + 1 \quad (6)$$

where the LPM can once again be written as:

$$LPM_{ni}(\tau) = \frac{1}{T}\sum_{t=1}^{T} \max[\tau - r_{it}, 0]^n \quad (7)$$

In this case the LPM of the order is observed. It should be clear from Equation 6 that Omega allows the user to specify the level of return against which a given outcome will be considered a profit or a loss, and is thus in essence a probability weighted ratio of profits to losses relative to a return threshold (Bertrand & Prigent, 2011).

The other measure employed that uses LPMs in the form of a maximum drawdown is the Calmar ratio. This ratio allows the user to express excess returns as a function of the maximum cumulative loss between a peak and a following bottom. The Calmar ratio can, therefore, be easily expressed as follows (adapted from Eling, 2008):

$$\text{Calmar ratio} = \frac{R_p - r_f}{-D_p} \quad (8)$$

where R_p is the average portfolio return for the period concerned; r_f is the risk-free rate for the same period, and $-D_p$ is the maximum drawdown. Although Magdon-Ismail and Atiya (2004) cautions against the use of the Calmar ratio in the form above, this issue is not applicable in our case since all comparisons are done over the same time frames.[3]

The final performance measure to be used is the EWMA model of JP Morgan. This model can provide substantial assistance in portfolio allocation and performance, even outperforming multivariate Generalised AutoRegressive Conditional Heteroskedasticity (GARCH) models (Giamouridis & Vrontos, 2007). This model can be illustrated as follows (J.P. Morgan/Reuters, 1996):

$$\sigma = \sqrt{(1-\lambda)\sum_{t=1}^{T} \lambda^{t-1}(r_t - \bar{r})^2} \quad (9)$$

where the EWMA model depends on the decay factor, λ $(0 < \lambda < 1)$, which determines the relative weights that must be applied to returns. In estimating the decay factor the following steps must be followed (J.P. Morgan/Reuters, 1996):

Firstly, Π must be calculated. This can be achieved by taking the sum of all N minimal Root-Mean-Square-Errors (RMSE), τ's:

$$= \sum_{i=1}^{N} \tau_i \quad (10)$$

where

$$\text{RMSE}_v = \frac{1}{T}\sum_{t=1}^{T} \left(r_{t+1}^2 - \hat{\sigma}_{(t+1|t)}^2\right)^2$$

Then, the relative error measure must be defined as follows:

$$\Theta_i = \frac{\tau_i}{\sum_{i=1}^{N} \Theta_i^{-1}} \quad (11)$$

[3] Magdon-Ismail and Atiya (2004) introduced a normalised Calmar ratio in order to circumvent the issue of comparing Calmar ratios over different periods.

Once the relative error measure is defined, the weight should be defined as follows:

$$\phi_i = \frac{\Theta_i^{-1}}{\sum_{i=1}^{N} \Theta_i^{-1}} \tag{12}$$

where

$$\sum_{i=1}^{N} \phi_i = 1$$

Finally, the optimal decay factor $\tilde{\lambda}$ can be defined as:

$$= \sum_{i=1}^{N} \phi_i \tilde{\lambda}_i \tag{13}$$

where the final optimal decay factor applied is the weighted average of individual optimal decay factors.

3. DATA AND RESULTS

The time series under investigation will be structured to incorporate two aspects that can affect hedge fund performance. Firstly, the data series were divided into three periods, where two of these periods incorporated a bullish phase and one incorporated a bearish phase. This approach was motivated by two previous studies. Although there is evidence that hedge funds are highly correlated with equity markets during a bearish phase (Edwards & Caglayan, 2001b), the studies of Ennis and Sebastian (2003) and Nicholas (2004) found evidence that hedge funds will outperform other markets during a bearish phase. Secondly, the empirical study will evaluate hedge fund performance in different financial environments. To accomplish this goal the three time periods were also chosen to incorporate a pre-financial crisis period, a during financial crisis period, and a post-financial crisis period, as illustrated by Figure 1.

The pre-financial crisis period (Period 1) spanned from January 2004 to December 2006, whereas the crisis period itself (Period 2) spanned from January 2007 to December 2009. The crisis period was selected to incorporate key events of the 2007 to 2009 financial crisis to ensure that the effect of the crisis can be evaluated effectively. Starting by incorporating the date when the Federal Home Loan Mortgage Corporation (Freddie Mac) announced that no more risky subprime mortgages and mortgage-related securities will be bought (27 February 2007), the takeover of Northern Rock by the UK Treasury (17 February 2008), and the announcements of Lehman Brothers Holdings Incorporated filing for bankruptcy on 15 September 2008. It also incorporates the announcement that President Obama would sign the American Recovery and Reinvestment Act of 2009, which included a variety of tax cuts and spending measures that were intended to promote economic recovery. All these events had a significant effect on global financial markets, which will make it ideal to investigate the superiority of hedge funds' investment flexibility. Finally, the post-financial crisis period stretches from January 2010 to December 2011, which will help to evaluate the performance of the US and EU hedge funds during the aftermath of the financial crisis.

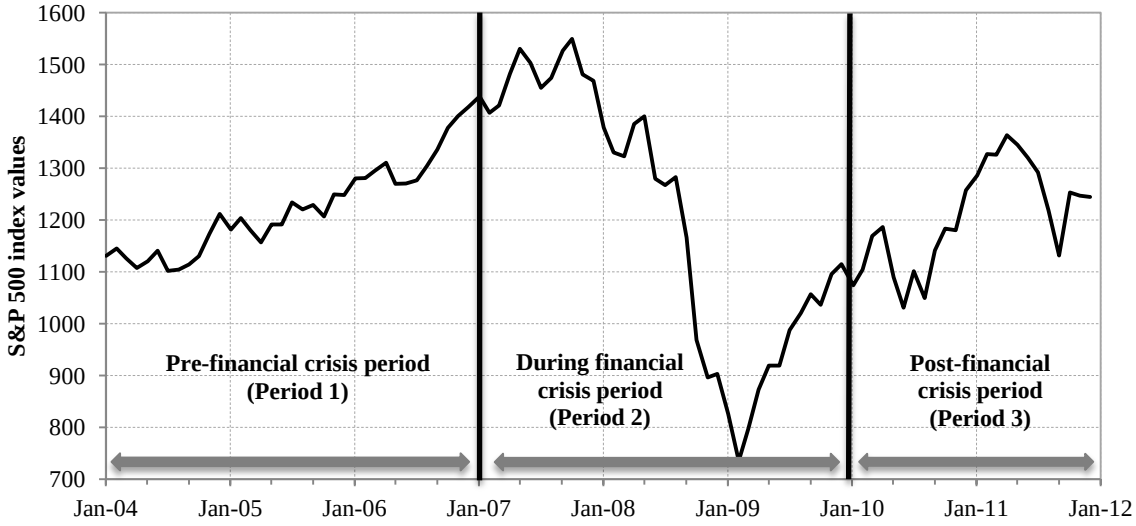

Figure 1: Sample Period Under Investigation – Illustrated by the S&P 500 Index
Source: Data were collected from Yahoo Finance (2013).

This study examines 38 prominent EU hedge funds and 84 US hedge funds. The performance of these hedge funds was estimated using monthly returns obtained from the Eurekahedge (2012) database. In order to determine whether the US or EU hedge funds outperformed associated equity markets, monthly return data were also obtained from Yahoo Finance (2012) for CAC 40, DAX, S&P 500 and for Dow Jones. Also, the 90-day US Treasury Bill rate (constant maturity) and the Euro area bond yield were chosen as the US and EU risk-free rates, respectively. To ensure that the rankings were comparable all the ratios were calculated with both the US and EU risk-free rates for all the hedge funds and indices, respectively. The 90-day US Treasury Bill rate series was obtained from the Board of the Federal Reserve System's (2012) website and the Euro area bond yield series was obtained from the International Monetary Fund (IMF) (2012) database, respectively.

To commence with the empirical results, it is imperative to firstly evaluate the descriptive statistics of each return series. Based on the study of Amin and Kat (2003), some return distributions tend to be non-linear and non-normally distributed, which will limit the performance ranking abilities of traditional performance ratios, like Jensen's alpha and the Sharpe ratio (Amin & Kat, 2003). This is especially true, if the divergence from normality becomes more apparent when the higher moments (kurtosis and skewness) of the return distributions are taken into account (Kat, 2003). Furthermore, very different portfolio allocations are possible, with the presence of non-normal returns, when comparing the traditional mean-variance framework to more advanced performance measures (see for example Fung & Hsieh, 1999a; Cvitanić, Lazrak, Martellini & Zapatero, 2003; McFall Lamm, 2003; Terhaar, Staub & Singer, 2003; Popova, Morton & Popova, 2003; Wong, Phoon & Lean, 2008). From the results reported in Table 1, it is plausible that non-normality will be present and there is a possibility of dissimilarities between performance rankings. The results in Table 1 reveal that both the EU and US hedge fund returns are leptokurtic, except for the EU hedge funds during the post-financial crisis period that illustrated a platykurtic distribution. These results justify the findings of Fung and Hsieh (1999b), who argued that hedge fund returns are known to be leptokurtic. Also, the world indices exhibit inconsistency during all three time periods, except for the CAC 40, who display a platykurtic distribution throughout all three time periods. Furthermore, all the returns series have a negative skewness, which imply the possibility of a downside surprise (see for example McFall Lamm, 2003), except for the US hedge funds, which have a positive skewness during the post-financial crisis period.

Table 1: Descriptive Statistics of the Returns of the Hedge Fund and World Indices

Descriptive Statistics of Hedge Funds								
Averages	**EU Hedge Funds**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.011	0.013	0.060	-0.046	0.024	-0.315	3.334	3.498**
During financial crisis period	0.002	0.004	0.091	-0.087	0.038	-0.089	4.174	13.401**
Post-financial crisis period	-0.001	-0.002	0.057	-0.069	0.032	-0.152	2.849	1.240**
Averages	**US Hedge Funds**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.008	0.009	0.067	-0.055	0.028	-0.200	3.423	4.580**
During financial crisis period	0.004	0.008	0.111	-0.130	0.050	-0.469	4.160	11.000**
Post-financial crisis period	0.003	0.003	0.101	-0.08	0.044	0.034	3.441	9.007**
Descriptive Statistics of World Indices								
Averages	**CAC 40**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.013	0.017	0.053	-0.05	0.026	-0.590	2.859	2.117**
During financial crisis period	-0.008	-0.009	0.126	-0.135	0.061	-0.270	2.768	0.518**
Post-financial crisis period	-0.008	-0.013	0.087	-0.113	0.056	-0.015	1.992	1.018**
Averages	**DAX**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.015	0.023	0.066	-0.053	0.031	-0.443	2.315	1.880**
During financial crisis period	0.000	0.018	0.168	-0.151	0.069	-0.284	3.156	0.520**
Post-financial crisis period	0.001	-0.001	0.116	-0.192	0.061	-0.899	5.577	9.875*
Averages	**S&P 500**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.007	0.011	0.037	-0.036	0.020	-0.443	2.296	1.921**
During financial crisis period	-0.008	0.009	0.086	-0.204	0.061	-1.077	4.307	9.519*
Post-financial crisis period	0.003	-0.001	0.097	-0.089	0.050	-0.041	2.262	0.551**
Averages	**DOW JONES**							
	Mean	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Skewness**	**Kurtosis**	**Jarque-Bera**
Pre-financial crisis period	0.005	0.006	0.038	-0.031	0.021	-0.091	1.853	2.024**
During financial crisis period	-0.006	0.001	0.079	-0.164	0.056	-0.932	3.711	5.972*
Post-financial crisis period	0.005	0.008	0.087	-0.086	0.044	-0.094	2.324	0.493**

** The null-hypothesis of a normal distribution is not rejected at a 5% confidence level. * The null-hypothesis of a normal distribution is rejected at a 5% confidence level. †Note: All the return series are also stationary at I(0), with both Augmented Dickey-Fuller functions including only an intercept and a trend and intercept, respectively. Source: Compiled by authors.

From these findings it can be argued that most of the return series ought to possess a non-normal distribution profile, however based on the average Jarque-Bera estimates, all the hedge funds are normally distributed. This is, however, a misperception created by looking at the averages only; in reality several of the US and EU hedge funds exhibited a non-normal distribution when looking at the individual funds. During the pre-financial crisis period six EU hedge funds and 22 US hedge funds are not normally distributed, whereas 10 EU hedge funds and 30 US hedge funds are not normally distributed during the crisis period. During the post-financial crisis period, this number decreased to only one EU hedge fund and thirteen US hedge funds not being normally distributed.

The DAX exhibits a non-normal distribution during the post-financial crisis period and the S&P 500 and Dow Jones exhibit a non-normal distribution during the crisis period. The CAC 40, on the other hand, had a normal distribution throughout all three periods. Furthermore, it can be argued that although the standard deviation of all these returns is relatively low, the presence of non-normality will lead to a misperception of the actual risk present. This is due to the high kurtosis and negative skewness which will cause the variance and standard deviation to

mimic a low overall risk, causing traditional performance measures, like the Sharpe ratio, to generate bias performance rankings (see for example Bernardo & Ledoit, 2000; McFall Lamm, 2003). Also, with the inconsistencies between normal and non-normal distributions, these performance measures will provide different rankings, which is inconsistent with the findings of Pfingsten, Wagner and Wolferink (2004), Pedersen and Rudholm-Alfvin (2003) and of Eling and Schuhmacher (2007), who found strong correlation between their rankings. This study will, therefore, make use of the Omega ratio as the main benchmark, to determine if the presence of non-normality have influenced the rankings of each performance measure. This approach is based on the fact that the Omega ratio treats upside and downside risk differently, thus heeding the criticism of the mean-variance portfolio optimisation of Markowitz (Gilli, Schumann, Di Tollo & Cabej, 2011, p. 95). The Omega ratio also includes information over the entire distribution encoded in the first four moments (Togher & Barsbay, 2007); it does not require any assumptions about any moments (De Wet, Krige & Smit, 2008); and thus no assumptions are required on the utility function of an investor (Favre-Bulle & Pache, 2003).

The second step of the empirical study will be to determine the level of correlation between the hedge funds, where the presence of correlation can cause the Sharpe ratio to generate bias performance rankings. This is based on Sharpe (1994) who argued that the Sharpe ratio assumes that individual securities are uncorrelated with the mean portfolio return. The results of Tables A through C in the appendix exhibit the presence of a moderate correlation level between the US and EU hedge funds. Although the overall correlation is positive, a few funds display a negative average correlation throughout the three time periods under investigation. Also, a small increase in average correlation was present among the hedge funds, although most hedge funds exhibit a decrease in average correlation during the post-financial crisis period to approximately the same level as the pre-financial crisis period. These findings reported in Tables A through C, therefore, further emphasise the possibility that the Sharpe ratio will generate bias performance rankings, due to the presence of correlation between the US and EU hedge funds. This implies that these rankings must be interpreted with extreme caution and must be benchmarked with the Omega ratio to ensure a more unbiased ranking.

Table 2: The Average Correlation between Hedge Funds and Equity Markets

	Pre-Financial Crisis Period				**During Financial Crisis Period**				**Post-Financial Crisis Period**			
Hedge Funds	**CAC 40**	**DAX**	**S&P 500**	**Dow Jones**	**CAC 40**	**DAX**	**S&P 500**	**Dow Jones**	**CAC 40**	**DAX**	**S&P 500**	**Dow Jones**
EU	0.577	0.533	0.408	0.340	0.554	0.524	0.493	0.444	0.481	0.461	0.509	0.488
US	0.389	0.428	0.498	0.407	0.571	0.576	0.572	0.510	0.608	0.562	0.689	0.667

Source: Compiled by authors.

The results in Table 2 indicate that most EU hedge funds showed a relative constant average correlation with the different world equity markets, with an increase in this correlation over the three time periods. This illustrates a higher dependence on equities, especially with the S&P 500 and Dow Jones. Although it was to be expected that the average correlation should increase during the financial crisis period and stabilise afterwards, the results displayed a continuation in this trend.

The US and EU hedge funds also exhibit a higher level of average correlation between S&P 500 and Dow Jones during the post-financial crisis period, which may be due to a lower level of anticipated risk (volatility) in these markets. These results do, therefore, not conclusively prove that US and EU hedge funds are more correlated with equity markets during bullish or bearish phases, which contradict the results found by Edwards and Caglayan (2001b). This implies that hedge funds may still have the ability to outperform equity markets during both a bearish and/or bullish phase, which will be established by the results found with the estimation of the different performance measures later on (see Tables 4 and 6).

Table 3: The Level of Volatility between the Hedge Funds and Equity Markets

Percentage of Hedge Funds Under the Top 10 Ranking for Highest Volatility			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**
EU Hedge Funds	20%	0%	0%
US Hedge Funds	80%	100%	100%
Ranking of Indices: A Ranking Closer to One is Associated with a Higher Level of Volatility (Risk)			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**
CAC 40	53	25	22
DAX	35	18	11
S&P 500	92	29	41
Dow Jones	97	34	55

[+] Note that the upper part of this table provides a summary of how many of the 84 US hedge funds, the 38 EU hedge funds and 4 world indices (a total of 126) ranked under the top 10 best performing entities. The bottom part of this table illustrates the rankings of the different equity indices from a total of 126, respectively. Source: Compiled by authors.

The third step of the empirical study will be to determine the level of volatility over the three different financial environment periods, which will be determined by estimating an Exponential Weighted Moving Average (EWMA) model. From Table 3 it is evident that US hedge funds exhibit the highest volatility level throughout all three time periods, based on the top 10 rankings. This implies that some US hedge funds consist of a higher level of risk compared to EU hedge funds, not only during the financial crisis period but also before and after the crisis period. These results accentuate the findings of Ackermann, McEnally and Ravenscraft (1999), where hedge funds were associated with higher volatility levels compared to market indices. Further results also display that the volatility level increased in the equity markets as well, and continued to increase in the CAC 40 and DAX even after the financial crisis, but decreased in the S&P 500 and Dow Jones. This emphasise the results found in Table 2, where US and EU hedge funds were more correlated with the S&P 500 and Dow Jones during the post-financial crisis period. These results, therefore, justify the fact that the S&P 500 and Dow Jones may have been associated as markets with a lesser degree of anticipated risk (volatility), making them more desirable during times where markets will exhibit extreme noise.

The fourth step of this empirical study is to determine if US or EU hedge funds were the more dominant funds over the three time periods, by means of the Sharpe, Sortino, Treynor, Jensen's alpha, Calmar and Omega ratios, respectively. In order to provide a more composite report, the following tables will report the percentage of the US and EU hedge funds that were ranked under the top 10 (best 10 performing hedge funds/equity markets). By doing so a more comprehensive conclusion can be made, regarding which hedge funds were the more dominant performers over the three periods. From the results reported in Table 4 it can be argued, based on the Sharpe, Sortino, Calmar and Omega ratio, that more US hedge funds were ranked under the top 10 best performing entities during the pre-financial crisis period. The one exception occurs where the Sharpe ratio (using the EU risk-free rate), emphasise the performance of the EU hedge funds. Even so, this dominance of the US hedge funds may be explained by the fact that US hedge funds were more volatile, based on the results from Tables 2 and 3. These results are also corroborated by the results reported in Table 5. It is clear that US hedge funds were able to generate a higher level of average cumulative returns during the crisis period and post-financial crisis periods. The EU hedge funds display a higher level of average cumulative returns during the pre-financial crisis period though (see Table 5), which is consistent with the results found by the Sharpe ratio in Table 4.

The results are, however, inconclusive during the crisis period, where the Sharpe and Omega ratios reported that EU hedge funds were more dominant under the top 10 rankings, while the Sortino ratio indicates that the US hedge funds are dominant. Although Omega and Sortino differ in terms of the top ranked hedge funds, they still rank hedge funds over the stock market indices. These findings contradict the findings of Duong (2008), who found that hedge funds tend to underperform equity markets when accounting for downside risk with the use of the Sortino and Omega ratios. The US and EU hedge funds also exhibit a similar performance during the crisis period based on the Calmar ratio's rankings.

The results for the post-financial crisis period are slightly different in that all the performance ratios reported that the US hedge funds were more dominant during the post-financial crisis period. This weaker performance of the EU hedge funds can partly be explained by the start of the European sovereign debt crisis in late

2009. This period saw a number of downgrades of government debt and rising government and private debt levels in some European states, therefore, decreasing investors' confidence in EU investments.

When assessing the overall picture it is evident that several US and EU hedge funds were able to outperform the equity markets during all three time periods. This was confirmed by all the performance measures. However, not all the measures placed the same funds in the same positions, a fact that can greatly be ascribed to the presence of non-normality in the return distributions. That is why the traditional performance measures, like the Sharpe ratio, should be benchmarked with the Omega ratio to overcome its shortcomings. Overall, these results contradict the results found by Ackermann, McEnally and Ravenscraft (1999) and Brown, Goetzmann and Ibbotson (1999). The results does, however, corroborate the results of Edwards and Caglayan (2001a), who reported that hedge funds tend to outperform equity markets in terms of traditional performance ratios, like the Sharpe ratio.

Table 4: Performance Evaluation

Sharpe Ratio							
Making Use of the EU Risk-Free Rate				**Making Use of the US Risk-Free Rate**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
EU Hedge Funds	50%	60%	30%	EU Hedge Funds	40%	60%	30%
US Hedge Funds	50%	40%	70%	US Hedge Funds	60%	40%	70%
Ranking of Indices Where One is the Most Superior				**Ranking of Indices Where One is the Most Superior**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
CAC 40	39	116	96	CAC 40	38	119	103
DAX	38	82	63	DAX	39	90	75
S&P 500	72	118	49	S&P 500	74	122	61
Dow Jones	110	115	38	Dow Jones	107	117	44
Sortino Ratio							
Using the EU Risk-Free Rate as Target Rate				**Using the US Risk-Free Rate as Target Rate**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
EU Hedge Funds	40%	40%	30%	EU Hedge Funds	40%	40%	30%
US Hedge Funds	60%	60%	70%	US Hedge Funds	60%	60%	70%
Ranking of Indices Where One is the Most Superior				**Ranking of Indices Where One is the Most Superior**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
CAC 40	44	117	96	CAC 40	57	124	109
DAX	39	82	60	DAX	58	97	75
S&P 500	77	112	48	S&P 500	76	118	60
Dow Jones	108	109	38	Dow Jones	111	125	48
Omega Ratio							
Using the EU Risk-Free Rate as the Threshold				**Using the US Risk-Free Rate as the Threshold**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
EU Hedge Funds	30%	60%	30%	EU Hedge Funds	30%	60%	30%
US Hedge Funds	70%	40%	70%	US Hedge Funds	70%	40%	70%
Ranking of Indices Where One is the Most Superior				**Ranking of Indices Where One is the Most Superior**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
CAC 40	46	120	99	CAC 40	48	118	99
DAX	54	91	73	DAX	54	93	74
S&P 500	78	122	61	S&P 500	78	122	61
Dow Jones	107	119	44	Dow Jones	105	119	44
CALMAR RATIO							
Percentage of Hedge Funds Under the Top 10							
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**				
EU Hedge Funds	40%	50%	30%				
US Hedge Funds	60%	50%	70%				
Ranking of Indices Where One is the Most Superior							
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**				
CAC 40	45	120	103				
DAX	21	93	75				
S&P 500	67	118	61				
Dow Jones	91	115	43				

[†]Note that the upper part of the table of each performance measure provides a summary of how many of the 84 US hedge funds, the 38 EU hedge funds, and 4 world indices (a total of 126) ranked under the top 10 best performing entities. The bottom part of each performance measure illustrates the rankings of the different equity indices from a total of 126, respectively. Source: Compiled by authors.

Table 5: The Average Cumulative Returns of the Different Hedge Funds

	Pre-Crisis Period	During Crisis Period	Post-Crisis Period
EU Hedge Funds	14.31%	1.85%	-1.43%
US Hedge Funds	10.14%	3.52%	3.00%

Source: Compiled by authors.

Table 6: Outperformance Evaluation

Sortino Ratio							
Making Use of the CAC 40 as the Target Rate				**Making Use of the DAX As the Target Rate**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
Eu Hedge Funds	60%	40%	20%	Eu Hedge Funds	60%	50%	30%
Us Hedge Funds	40%	60%	80%	Us Hedge Funds	40%	50%	70%
Treynor Ratio							
Using the CAC 40 as the Market Portfolio				**Using the DAX as the Market Portfolio**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
Eu Hedge Funds	10%	10%	30%	Eu Hedge Funds	20%	20%	30%
Us Hedge Funds	90%	90%	70%	Us Hedge Funds	80%	80%	70%
Using the S&P 500 as the Market Portfolio				**Using the Dow Jones as the Market Portfolio**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
Eu Hedge Funds	40%	20%	20%	Eu Hedge Funds	40%	30%	20%
Us Hedge Funds	60%	80%	80%	Us Hedge Funds	60%	70%	80%
Jensen's Alpha							
Using the CAC 40 as the Market Portfolio				**Using the DAX as the Market Portfolio**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
Eu Hedge Funds	80%	40%	30%	Eu Hedge Funds	80%	60%	40%
Us Hedge Funds	20%	60%	70%	Us Hedge Funds	20%	40%	60%
Using the S&P 500 as the Market Portfolio				**Using the Dow Jones as the Market Portfolio**			
Percentage of Hedge Funds Under the Top 10				**Percentage of Hedge Funds Under the Top 10**			
	Pre-Crisis Period	**During Crisis Period**	**Post-Crisis Period**		**Pre-Crisis Period**	**During Crisis Period**	**Post-Crisis Period**
Eu Hedge Funds	10%	50%	50%	Eu Hedge Funds	10%	60%	60%
Us Hedge Funds	90%	50%	50%	Us Hedge Funds	90%	40%	40%

[+]Note that the upper part of the table of each performance measure provides a summary of how many of the 84 US hedge funds, the 38 EU hedge funds, and 4 world indices (a total of 126) ranked under the top 10 entities. Source: Compiled by authors.

In order to check the robustness of the results, in terms of the presence of outperformance, the Sortino ratio was estimated with the CAC 40 and DAX as target rates, respectively. This approach was also followed in the estimation of the Treynor ratio and the Jensen's alpha, where all four equity markets were used as the market

portfolio, respectively. The results from Table 6 emphasise that several US and EU hedge funds were able to outperform the equity markets during all three time periods. Based on the results of the Sortino ratio, EU hedge funds were able to outperform the CAC 40 and the DAX more frequently than US hedge funds could during the pre-financial crisis period. Several EU hedge funds also outperformed the DAX during the crisis period. These results were also confirmed by Jensen's alpha, reporting that EU hedge funds outperformed the CAC 40 more often than the US hedge funds during the pre-financial crisis period and outperformed the DAX more often than the US hedge funds during the pre-crisis and crisis periods. However, Jensen's alpha also reported similar performance for both US and EU hedge funds, where they exhibit similar performance in outperforming the S&P 500 during the crisis and post-financial crisis periods. Evidence from Table 6 further shows that EU hedge funds were able to outperform the Dow Jones more often than US hedge funds during the crisis and post-financial crisis periods.

From the remaining results reported by the Sortino ratio and Jensen's alpha, it is confirmed that US hedge funds were able to outperform the CAC 40 and the DAX more often than EU hedge funds. These findings were further stressed by the results of the Treynor ratio, where the US hedge funds exhibit greater incidence of outperforming all the equity markets during all three time periods than EU hedge funds did. From these results it is conclusive that although US hedge funds exhibited a higher level of volatility throughout the three time periods, they were also more likely to illustrate greater overall performance than EU hedge funds and equity markets. The results from Table 6 also illustrates that hedge funds were able to outperform their associated equity markets during both a bearish and bullish phase. The results from this study, therefore, emphasise the ability of hedge funds to use its investment flexibility during different financial environments to outperform equity markets, thus making hedge funds the more superior investment vehicle.

4. CONCLUSION AND RECOMMENDATIONS

Conflicting evidence regarding the performance of hedge funds and their persistence in outperforming other markets have been debated by a number of previous studies. Generally, it is assumed that due to the flexibility of hedge funds, in being able to apply different investment strategies, will make them the more considered unconventional asset choice. However, previous research seems to suggest that hedge funds tend to be correlated with equity markets, implying the possibility of hedge funds underperforming during bearish phases. The relatively high attrition rate among hedge funds coupled with their non-normally distributed returns (exhibiting high kurtosis and negative skewness), makes it also difficult to provide a detailed performance evaluation of all the hedge funds.

Since non-normal distributions were also present in this study, all risk-adjusted performance results were benchmarked to the Omega ratio, in an attempt to overcome most of the shortcomings of traditional performance measures. From the results if was evident that several US and EU hedge funds were able to outperform the CAC 40, the DAX, the S&P 500, and the Dow Jones during both a bearish and bullish phase. Also, although the US hedge funds illustrated greater volatility compared to EU hedged funds, evidence from the risk-adjusted performance measures supported the overall dominance of US hedge funds. These findings further emphasised that a normal buy-and-hold strategy on the four world equity indices under investigation, would have been overshadowed by the performance of the US and EU hedge funds despite a higher correlation between the hedge funds and the Dow Jones and S&P 500 after the financial crisis period.

These results pose a number of further questions. The first is whether different data frequencies will render different results. It would also be interesting to look at the level of cost and resource allocation efficiency of hedge funds when compared to other investment vehicles. Further research is also required on US and EU hedge funds' ability to time the market. It would also be interesting to draw a risk-weighted returns comparison between these hedge funds and mutual funds, since mutual funds are often viewed as 'safe' investment vehicles.

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APPENDIX

Table A: Average Correlation of EU Hedge Funds with the US Hedge Funds

Pre-Financial Crisis Period			During-Financial Crisis Period			Post-Financial Crisis Period		
EU Hedge Fund	1	0.369	EU Hedge Fund	1	0.479	EU Hedge Fund	1	0.394
EU Hedge Fund	2	0.373	EU Hedge Fund	2	0.484	EU Hedge Fund	2	0.395
EU Hedge Fund	3	0.313	EU Hedge Fund	3	0.438	EU Hedge Fund	3	0.465
EU Hedge Fund	4	0.319	EU Hedge Fund	4	0.439	EU Hedge Fund	4	0.478
EU Hedge Fund	5	0.338	EU Hedge Fund	5	0.501	EU Hedge Fund	5	0.410
EU Hedge Fund	6	0.342	EU Hedge Fund	6	0.501	EU Hedge Fund	6	0.414
EU Hedge Fund	7	0.346	EU Hedge Fund	7	0.500	EU Hedge Fund	7	0.412
EU Hedge Fund	8	0.107	EU Hedge Fund	8	-0.082	EU Hedge Fund	8	0.122
EU Hedge Fund	9	0.280	EU Hedge Fund	9	0.471	EU Hedge Fund	9	0.618
EU Hedge Fund	10	0.281	EU Hedge Fund	10	0.472	EU Hedge Fund	10	0.609
EU Hedge Fund	11	0.273	EU Hedge Fund	11	0.343	EU Hedge Fund	11	0.019
EU Hedge Fund	12	0.367	EU Hedge Fund	12	0.285	EU Hedge Fund	12	0.397
EU Hedge Fund	13	0.297	EU Hedge Fund	13	0.348	EU Hedge Fund	13	0.075
EU Hedge Fund	14	0.328	EU Hedge Fund	14	0.518	EU Hedge Fund	14	0.433
EU Hedge Fund	15	0.334	EU Hedge Fund	15	0.520	EU Hedge Fund	15	0.450
EU Hedge Fund	16	0.342	EU Hedge Fund	16	0.506	EU Hedge Fund	16	0.449
EU Hedge Fund	17	0.374	EU Hedge Fund	17	0.480	EU Hedge Fund	17	0.613
EU Hedge Fund	18	0.358	EU Hedge Fund	18	0.556	EU Hedge Fund	18	0.512
EU Hedge Fund	19	0.392	EU Hedge Fund	19	0.572	EU Hedge Fund	19	0.586
EU Hedge Fund	20	0.387	EU Hedge Fund	20	0.510	EU Hedge Fund	20	0.618
EU Hedge Fund	21	0.267	EU Hedge Fund	21	0.155	EU Hedge Fund	21	0.312
EU Hedge Fund	22	-0.100	EU Hedge Fund	22	-0.068	EU Hedge Fund	22	0.292
EU Hedge Fund	23	-0.091	EU Hedge Fund	23	-0.048	EU Hedge Fund	23	0.281
EU Hedge Fund	24	0.350	EU Hedge Fund	24	0.575	EU Hedge Fund	24	0.509
EU Hedge Fund	25	0.247	EU Hedge Fund	25	0.358	EU Hedge Fund	25	0.625
EU Hedge Fund	26	0.395	EU Hedge Fund	26	0.480	EU Hedge Fund	26	0.259
EU Hedge Fund	27	0.410	EU Hedge Fund	27	0.479	EU Hedge Fund	27	0.243
EU Hedge Fund	28	0.393	EU Hedge Fund	28	0.478	EU Hedge Fund	28	0.259
EU Hedge Fund	29	0.299	EU Hedge Fund	29	0.099	EU Hedge Fund	29	0.162
EU Hedge Fund	30	0.299	EU Hedge Fund	30	0.058	EU Hedge Fund	30	0.161
EU Hedge Fund	31	0.467	EU Hedge Fund	31	0.543	EU Hedge Fund	31	0.463
EU Hedge Fund	32	0.432	EU Hedge Fund	32	0.578	EU Hedge Fund	32	0.454
EU Hedge Fund	33	0.112	EU Hedge Fund	33	-0.153	EU Hedge Fund	33	-0.301
EU Hedge Fund	34	0.257	EU Hedge Fund	34	0.306	EU Hedge Fund	34	0.410
EU Hedge Fund	35	0.256	EU Hedge Fund	35	0.312	EU Hedge Fund	35	0.408
EU Hedge Fund	36	0.254	EU Hedge Fund	36	0.305	EU Hedge Fund	36	0.409
EU Hedge Fund	37	0.123	EU Hedge Fund	37	0.368	EU Hedge Fund	37	0.248
EU Hedge Fund	38	0.144	EU Hedge Fund	38	0.381	EU Hedge Fund	38	0.294

Source: Compiled by authors.

Table B: Average Correlation of EU Hedge Funds with the Other EU Hedge Funds

Pre-Financial Crisis Period			During-Financial Crisis Period			Post-Financial Crisis Period		
EU Hedge Fund	1	0.637	EU Hedge Fund	1	0.537	EU Hedge Fund	1	0.429
EU Hedge Fund	2	0.634	EU Hedge Fund	2	0.541	EU Hedge Fund	2	0.426
EU Hedge Fund	3	0.591	EU Hedge Fund	3	0.480	EU Hedge Fund	3	0.472
EU Hedge Fund	4	0.588	EU Hedge Fund	4	0.476	EU Hedge Fund	4	0.482
EU Hedge Fund	5	0.541	EU Hedge Fund	5	0.498	EU Hedge Fund	5	0.465
EU Hedge Fund	6	0.543	EU Hedge Fund	6	0.497	EU Hedge Fund	6	0.464
EU Hedge Fund	7	0.546	EU Hedge Fund	7	0.496	EU Hedge Fund	7	0.465
EU Hedge Fund	8	0.227	EU Hedge Fund	8	-0.042	EU Hedge Fund	8	0.112
EU Hedge Fund	9	0.593	EU Hedge Fund	9	0.515	EU Hedge Fund	9	0.539
EU Hedge Fund	10	0.578	EU Hedge Fund	10	0.513	EU Hedge Fund	10	0.535
EU Hedge Fund	11	0.459	EU Hedge Fund	11	0.335	EU Hedge Fund	11	0.165
EU Hedge Fund	12	0.590	EU Hedge Fund	12	0.300	EU Hedge Fund	12	0.303
EU Hedge Fund	13	0.547	EU Hedge Fund	13	0.333	EU Hedge Fund	13	0.198
EU Hedge Fund	14	0.591	EU Hedge Fund	14	0.521	EU Hedge Fund	14	0.467
EU Hedge Fund	15	0.588	EU Hedge Fund	15	0.523	EU Hedge Fund	15	0.478
EU Hedge Fund	16	0.583	EU Hedge Fund	16	0.518	EU Hedge Fund	16	0.476
EU Hedge Fund	17	0.548	EU Hedge Fund	17	0.471	EU Hedge Fund	17	0.476
EU Hedge Fund	18	0.593	EU Hedge Fund	18	0.539	EU Hedge Fund	18	0.412
EU Hedge Fund	19	0.606	EU Hedge Fund	19	0.551	EU Hedge Fund	19	0.524
EU Hedge Fund	20	0.518	EU Hedge Fund	20	0.502	EU Hedge Fund	20	0.489
EU Hedge Fund	21	0.546	EU Hedge Fund	21	0.219	EU Hedge Fund	21	0.226
EU Hedge Fund	22	0.036	EU Hedge Fund	22	-0.070	EU Hedge Fund	22	0.205
EU Hedge Fund	23	0.039	EU Hedge Fund	23	-0.050	EU Hedge Fund	23	0.199
EU Hedge Fund	24	0.578	EU Hedge Fund	24	0.577	EU Hedge Fund	24	0.386
EU Hedge Fund	25	0.338	EU Hedge Fund	25	0.372	EU Hedge Fund	25	0.516
EU Hedge Fund	26	0.595	EU Hedge Fund	26	0.476	EU Hedge Fund	26	0.391
EU Hedge Fund	27	0.584	EU Hedge Fund	27	0.476	EU Hedge Fund	27	0.383
EU Hedge Fund	28	0.597	EU Hedge Fund	28	0.475	EU Hedge Fund	28	0.391
EU Hedge Fund	29	0.497	EU Hedge Fund	29	0.178	EU Hedge Fund	29	0.272
EU Hedge Fund	30	0.507	EU Hedge Fund	30	0.154	EU Hedge Fund	30	0.274
EU Hedge Fund	31	0.640	EU Hedge Fund	31	0.509	EU Hedge Fund	31	0.529
EU Hedge Fund	32	0.656	EU Hedge Fund	32	0.558	EU Hedge Fund	32	0.518
EU Hedge Fund	33	0.421	EU Hedge Fund	33	-0.156	EU Hedge Fund	33	-0.263
EU Hedge Fund	34	0.457	EU Hedge Fund	34	0.331	EU Hedge Fund	34	0.351
EU Hedge Fund	35	0.457	EU Hedge Fund	35	0.336	EU Hedge Fund	35	0.349
EU Hedge Fund	36	0.455	EU Hedge Fund	36	0.331	EU Hedge Fund	36	0.349
EU Hedge Fund	37	0.145	EU Hedge Fund	37	0.316	EU Hedge Fund	37	0.277
EU Hedge Fund	38	0.154	EU Hedge Fund	38	0.321	EU Hedge Fund	38	0.301

Source: Compiled by authors.

Table C: Average Correlation of US Hedge Funds with the Other US Hedge Funds

Pre-Financial Crisis Period			During-Financial Crisis Period			Post-Financial Crisis Period		
US Hedge Fund	1	0.282	US Hedge Fund	1	0.512	US Hedge Fund	1	0.618
US Hedge Fund	2	0.326	US Hedge Fund	2	0.482	US Hedge Fund	2	0.616
US Hedge Fund	3	0.533	US Hedge Fund	3	0.610	US Hedge Fund	3	0.608
US Hedge Fund	4	0.139	US Hedge Fund	4	0.504	US Hedge Fund	4	0.616
US Hedge Fund	5	0.235	US Hedge Fund	5	0.573	US Hedge Fund	5	0.676
US Hedge Fund	6	0.241	US Hedge Fund	6	0.545	US Hedge Fund	6	0.672
US Hedge Fund	7	0.448	US Hedge Fund	7	0.570	US Hedge Fund	7	0.660
US Hedge Fund	8	0.448	US Hedge Fund	8	0.573	US Hedge Fund	8	0.659
US Hedge Fund	9	0.460	US Hedge Fund	9	0.525	US Hedge Fund	9	0.555
US Hedge Fund	10	0.410	US Hedge Fund	10	0.498	US Hedge Fund	10	0.541
US Hedge Fund	11	0.320	US Hedge Fund	11	0.458	US Hedge Fund	11	0.318
US Hedge Fund	12	-0.163	US Hedge Fund	12	0.077	US Hedge Fund	12	-0.277
US Hedge Fund	13	0.329	US Hedge Fund	13	0.594	US Hedge Fund	13	0.631
US Hedge Fund	14	0.511	US Hedge Fund	14	0.471	US Hedge Fund	14	0.605
US Hedge Fund	15	0.509	US Hedge Fund	15	0.470	US Hedge Fund	15	0.604
US Hedge Fund	16	0.460	US Hedge Fund	16	0.570	US Hedge Fund	16	0.621
US Hedge Fund	17	0.183	US Hedge Fund	17	0.558	US Hedge Fund	17	0.556
US Hedge Fund	18	0.336	US Hedge Fund	18	0.347	US Hedge Fund	18	0.660
US Hedge Fund	19	0.493	US Hedge Fund	19	0.552	US Hedge Fund	19	0.592
US Hedge Fund	20	0.441	US Hedge Fund	20	0.536	US Hedge Fund	20	0.521
US Hedge Fund	21	0.335	US Hedge Fund	21	0.462	US Hedge Fund	21	0.675
US Hedge Fund	22	0.244	US Hedge Fund	22	0.473	US Hedge Fund	22	0.563
US Hedge Fund	23	0.422	US Hedge Fund	23	0.516	US Hedge Fund	23	0.615
US Hedge Fund	24	0.367	US Hedge Fund	24	0.570	US Hedge Fund	24	0.419
US Hedge Fund	25	0.412	US Hedge Fund	25	0.509	US Hedge Fund	25	0.529
US Hedge Fund	26	0.413	US Hedge Fund	26	0.506	US Hedge Fund	26	0.527
US Hedge Fund	27	0.414	US Hedge Fund	27	0.517	US Hedge Fund	27	0.533
US Hedge Fund	28	0.408	US Hedge Fund	28	0.523	US Hedge Fund	28	0.282
US Hedge Fund	29	0.539	US Hedge Fund	29	0.591	US Hedge Fund	29	0.673
US Hedge Fund	30	0.385	US Hedge Fund	30	0.312	US Hedge Fund	30	0.650
US Hedge Fund	31	0.394	US Hedge Fund	31	0.419	US Hedge Fund	31	0.561
US Hedge Fund	32	-0.035	US Hedge Fund	32	0.008	US Hedge Fund	32	0.325
US Hedge Fund	33	0.518	US Hedge Fund	33	0.538	US Hedge Fund	33	0.547
US Hedge Fund	34	0.528	US Hedge Fund	34	0.606	US Hedge Fund	34	0.679
US Hedge Fund	35	0.544	US Hedge Fund	35	0.536	US Hedge Fund	35	0.674
US Hedge Fund	36	0.425	US Hedge Fund	36	0.462	US Hedge Fund	36	0.464
US Hedge Fund	37	0.341	US Hedge Fund	37	0.501	US Hedge Fund	37	0.560
US Hedge Fund	38	0.379	US Hedge Fund	38	0.494	US Hedge Fund	38	0.552
US Hedge Fund	39	0.467	US Hedge Fund	39	0.487	US Hedge Fund	39	0.616
US Hedge Fund	40	0.431	US Hedge Fund	40	0.547	US Hedge Fund	40	0.129
US Hedge Fund	41	0.301	US Hedge Fund	41	0.211	US Hedge Fund	41	0.624
US Hedge Fund	42	0.301	US Hedge Fund	42	0.210	US Hedge Fund	42	0.624
US Hedge Fund	43	0.302	US Hedge Fund	43	0.220	US Hedge Fund	43	0.625
US Hedge Fund	44	0.406	US Hedge Fund	44	0.159	US Hedge Fund	44	-0.298
US Hedge Fund	45	0.320	US Hedge Fund	45	0.464	US Hedge Fund	45	0.436
US Hedge Fund	46	0.008	US Hedge Fund	46	0.299	US Hedge Fund	46	0.365
US Hedge Fund	47	0.025	US Hedge Fund	47	0.299	US Hedge Fund	47	0.365
US Hedge Fund	48	0.446	US Hedge Fund	48	0.348	US Hedge Fund	48	0.582
US Hedge Fund	49	0.321	US Hedge Fund	49	0.313	US Hedge Fund	49	0.578
US Hedge Fund	50	0.512	US Hedge Fund	50	0.571	US Hedge Fund	50	0.662
US Hedge Fund	51	0.321	US Hedge Fund	51	0.312	US Hedge Fund	51	0.578
US Hedge Fund	52	0.483	US Hedge Fund	52	0.585	US Hedge Fund	52	0.680
US Hedge Fund	53	0.519	US Hedge Fund	53	0.588	US Hedge Fund	53	0.677
US Hedge Fund	54	0.515	US Hedge Fund	54	0.605	US Hedge Fund	54	0.672
US Hedge Fund	55	0.542	US Hedge Fund	55	0.596	US Hedge Fund	55	0.675

Table C cont.

US Hedge Fund	56	0.338	US Hedge Fund	56	0.489	US Hedge Fund	56	0.679
US Hedge Fund	57	-0.115	US Hedge Fund	57	0.050	US Hedge Fund	57	-0.064
US Hedge Fund	58	0.352	US Hedge Fund	58	0.375	US Hedge Fund	58	0.279
US Hedge Fund	59	0.448	US Hedge Fund	59	0.565	US Hedge Fund	59	0.570
US Hedge Fund	60	0.415	US Hedge Fund	60	0.426	US Hedge Fund	60	0.328
US Hedge Fund	61	0.415	US Hedge Fund	61	0.420	US Hedge Fund	61	0.325
US Hedge Fund	62	0.418	US Hedge Fund	62	0.416	US Hedge Fund	62	0.303
US Hedge Fund	63	0.422	US Hedge Fund	63	0.429	US Hedge Fund	63	0.331
US Hedge Fund	64	0.045	US Hedge Fund	64	0.351	US Hedge Fund	64	0.358
US Hedge Fund	65	0.062	US Hedge Fund	65	0.348	US Hedge Fund	65	0.347
US Hedge Fund	66	0.516	US Hedge Fund	66	0.540	US Hedge Fund	66	0.661
US Hedge Fund	67	0.467	US Hedge Fund	67	0.463	US Hedge Fund	67	0.504
US Hedge Fund	68	0.271	US Hedge Fund	68	0.223	US Hedge Fund	68	0.420
US Hedge Fund	69	0.452	US Hedge Fund	69	0.348	US Hedge Fund	69	0.529
US Hedge Fund	70	0.353	US Hedge Fund	70	0.149	US Hedge Fund	70	0.385
US Hedge Fund	71	0.355	US Hedge Fund	71	0.152	US Hedge Fund	71	0.385
US Hedge Fund	72	0.489	US Hedge Fund	72	0.537	US Hedge Fund	72	0.650
US Hedge Fund	73	0.422	US Hedge Fund	73	0.542	US Hedge Fund	73	0.680
US Hedge Fund	74	0.409	US Hedge Fund	74	0.356	US Hedge Fund	74	0.545
US Hedge Fund	75	0.413	US Hedge Fund	75	0.357	US Hedge Fund	75	0.547
US Hedge Fund	76	0.434	US Hedge Fund	76	0.561	US Hedge Fund	76	0.639
US Hedge Fund	77	0.205	US Hedge Fund	77	0.508	US Hedge Fund	77	0.603
US Hedge Fund	78	0.262	US Hedge Fund	78	0.425	US Hedge Fund	78	0.521
US Hedge Fund	79	-0.085	US Hedge Fund	79	-0.251	US Hedge Fund	79	-0.090
US Hedge Fund	80	0.343	US Hedge Fund	80	0.482	US Hedge Fund	80	0.615
US Hedge Fund	81	0.474	US Hedge Fund	81	0.482	US Hedge Fund	81	0.642
US Hedge Fund	82	0.525	US Hedge Fund	82	0.537	US Hedge Fund	82	0.652
US Hedge Fund	83	0.523	US Hedge Fund	83	0.536	US Hedge Fund	83	0.651
US Hedge Fund	84	-0.014	US Hedge Fund	84	-0.070	US Hedge Fund	84	-0.198

Source: Compiled by authors.

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